IPP TECHNICAL EVALUATION
Final Report

US Partner:	University of Connecticut, Environmental Research Institute
NIS Partners:	Western Center of the Ukrainian Branch of the World Laboratory (Lviv), I. Franko State University (Lviv), Lviv Polytechnical State University
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The present technical evaluation report is prepared on the basis of the review of the briefing materials provided by IREX and the site visit to Lviv on November 10-15, 1996. During the site visit the evaluator attended the seminar on Environmental Biotechnology (November 11-12, 1996), reviewed materials in the Environmental Technology Resource Center (short course manuals, materials of seminars and other literature, computer programs and databases), and attended a lecture of the pollution prevention course taught by Petro Hrytsyshyn at Lviv Polytechnical University. The evaluator met with the participants of the summer program in the Environmental Research Institute of Connecticut University: Olena Popovych, Vladimir Vasilechko, Stepan Chikhriy, Ihor Polyuzhyn, Natalia Genega. The evaluator also reviewed programs of courses, which were taught or prepared using material obtained during the ERI program. The evaluator had a meeting with Dr. Markian Pavlykevych, Prorector of Lviv Polytechnical State University and a member of the ETTEC (Environmental Technology Transfer and Education Collaboration) advisory board. The evaluator also interviewed several participants of the seminar.

A. The strongest and the weakest aspects of technical and professional work being done by the ETTEC partnership.

The principal goal of the partnership is the promotion of advanced environmentally sound technologies through a series of seminars for industry professionals and university students. The program participants, most of whom teach at I. Franko State University and Lviv Polytechnical University, are young professionals who are highly motivated and interested in the program. They consider the program a great opportunity for their further professional development. This factor considerably enhances the quality of seminars and course teaching. Project staff, especially Petro Hrytsyshyn and Volodymyr Tounytsky, are open to new ideas and are constantly seeking new possibilities for expanding project activities.

The content of the program is comprised of technological and analytical issues of environmental protection and control. A very strong aspect of this program is that it promotes the idea of pollution prevention. Traditionally, environmental protection in industrial production used the end-of-pipe approach, that is, the waste generated in the production process was treated before being released into the environment. This considerably increased overall production costs. For this reason businesses always resisted environmental protection laws and measures, which created

antagonism between them and the regulating authorities. Pollution prevention and waste minimization are a relatively new idea in the Western World. It is now known that technological processes can be adjusted so that less or even no waste is produced. This often proves to be economically effective and allows companies to cut their costs by avoiding fines and related litigation expenses for polluting the environment, avoiding waste treatment and disposal costs, as well as by increasing the efficiency of technological processes. This has resulted in the steady "greening" of businesses in the USA and Western Europe in the recent decade. In the USSR some authors were also calling for low-waste and no-waste production processes. But the development of the environmental protection system followed the end-of-pipe control approach. Resources were spent on coping with consequences instead of eliminating the causes. Introduction and promotion of the idea of pollution prevention in Ukraine can provide the means to achieve two goals in developing industry: protect the environment and cut production costs to make products competitive in international markets.

Another positive aspect of the program is that it does not exclusively focus on the technological issues, but also includes legal and economic issues of environmental protection, which provide the framework for technology application.

It should also be mentioned how efficiently the training program was organized. A group of university teachers and scientists, who already had thorough knowledge in the field of environmental technology and analytical techniques, received intensive training at ERI in the most advanced developments in the field. In Ukraine these program participants transfer this knowledge and share materials with their university colleagues, students and representatives of industry, and local regulating authorities, which ensures that a maximum number of people can benefit from the program.

The drawback of the selection of the intensive training participants is that only one person, Natalia Genega, is working in the field of production technology. Others work in the field of waste treatment and analytical control. This reflects the general perception of production and environmental control in industry as two completely separate issues. But it is regrettable that the program, which included concepts which are aimed at changing this situation, did not try to attract more production specialists.

At present the program's target audience consists of industry representatives and students of Lviv Polytechnical University, and the Chemistry Department of I. Franko State University. Representatives of industrial enterprises who attend program seminars typically work in the departments of pollution control and environmental protection of their companies. These departments typically monitor the quality and composition of air within the enterprise, water emissions, and control health and safety conditions in the working place. So people who attend seminars are mostly interested in new analytical methods of environmental control, which they can apply in their work, rather than technological issues and pollution prevention. The ETTEC Center should try to attract heads of enterprises and technology engineers to its seminars so that they can be exposed to the ideas of pollution prevention. These people heavily influence a company's operation and traditionally view environmental protection issues as marginal to production processes and adverse for economic efficiency. Educating these individuals in the field of pollution

prevention as an economically effective way of protecting the environment would create a favorable atmosphere for pollution control in industrial enterprises.

The same applies to teaching university courses. At present, the course on pollution prevention is taught to students who specialize in environmental engineering, that is, ways of treating wastes created by technological processes. The evaluator believes that pollution prevention should be taught to students of all technological qualifications, and that the ETTEC program could promote this idea through its advisory board and assist with teaching by providing its materials. Students of Business and Economics would also benefit from exposure to the ideas of pollution prevention.

The program should also approach the authorities and the press, which can provide powerful support toward the promotion of pollution prevention ideas. The support of the Lviv authorities should facilitate access to enterprise senior offices. At present project participants are trying to establish closer relationships with local authorities and pursue possibilities to work with journalists.

Recommendations:
It is beneficial for the program to broaden the target audience to include enterprise management, local authorities, and students of all technological disciplines including business administration and economics. The program should prepare a special seminar for industry senior managers on "green" economics and pollution prevention, devoted mostly to its economics aspects.

B. "Criteria for success" for the partnership project activities.

According to the program managers, their "criteria for success" are as follows. The seminars are evaluated by a number of the participants. The evaluations solicited from seminar participants offer feedback on the seminar content and organization. Participation in the seminars is steadily growing. The Biotechnology seminar was attended by industry representatives from Ivano-Frankovsk region, which is adjacent to the Lviv region. A typical rating of the seminar by attendees was excellent or good.

The criteria for success of the University courses are; student attendance and the decision of universities to continue teaching courses and to introduce new ones. According to project participants and based on the evaluator visit to one of the lectures, the attendance rate is high and students are interested in the subject. Senior students also attended the Biotechnology seminar. The courses read at present are all included in the program plan of Lviv Polytechnical University, so they will remain a part of the curriculum. The decision concerning the new courses to be prepared at I. Franko University was not yet known.

The criteria for success of the Resource center operation are attendance and use of literature, including short course manuals from ERI training program. According to Volodymyr Tounytsky the Center attendance is rather low and below expected. This can be attributed to the relatively short time of the Center operation (since April, 1996), its location far from universities, and the fact that such a center is very new and untraditional for Ukraine. From interviews with seminar attendees the evaluator learned that none of them ever used the Center as a source of information

other than seminars. Students at the lecture which was held in the Center, expressed interest in using the Center's material, but seemed ill informed about the Center's attendance policy and working hours, despite printed ads placed at Lviv Polytechnical University. This problem can be solved by continuously reminding seminar participants and students about the availability of the Center.

The information about the Center is also being spread by word-of-mouth by people who have already used it: colleagues of the project participants from the universities who use manuals, students who used manual materials in their course work, etc. So one should expect an increase in attendance in the future.

Another restriction on the Center's operation is that the majority of the library materials are in English. This problem is now being solved, as publications in Russian and Polish were ordered.

Recommendations:
These success criteria are fully appropriate at the current stage of project operation. In the future, the criteria for success should also include the application of Center materials and training by industry and their use in student and faculty research work.

C. Technical merit and appropriateness of program components.
1. Training.

All participants highly rated the training they received at ERI. They especially praised the Environmental Analysis Module which covered issues of sampling design, analytical analysis, and data validation. Participants also remarked on what a great value the practical work in the ERI laboratories and company visits arranged during training was for them. This training allowed them to improve the courses they already taught and develop new ones. Natalia Genega, who is the only ERI training participant working in industry, is currently using obtained knowledge for the development of a technological scheme for the reconstruction of a high-precision micro-metal-plating operation in the city of Drohobych in the Lviv region, to make it safe in terms of occupational and environmental safety. She says that seeing the already operating US facility where these conditions were ensured helped her a lot both in development work and in persuading her managers that it is possible and effective.

Most of the participants of the ERI training program now deliver seminars to industry representatives and teach students. The seminar participants that were interviewed said that the information they were getting was interesting and increased their general awareness in the field of environmental technology. Some of the participants especially noted the seminars on Water Treatment (Municipal and Industrial) and lectures on the methods of analytical control from different seminars. The majority of people who attend seminars work in the departments of environmental control and health and safety, so they are mostly interested in issues of analytical instrumental control of emissions and work place conditions. Other seminar materials, especially from the Biotechnology seminar, seemed to be rather irrelevant to their work. Others considered it useful for their professional development because they were learning more about new developments in the field of environmental technology. None of the interviewed participants were

able to date to use any of the seminar information in their practical work. One of the attendees said that he got information about the seminars from the city occupational safety authorities, which suggested attending them as an alternative to the state qualification enhancement program, which all industry specialists are required to attend once every five years.

In this evaluator's opinion the seminars have several merits. They provide participants with information on the recent developments in different areas of environmental technology, thus increasing the general level of industry environmental professionals in the area. Covered subjects (air and water pollution control and treatment) are in general relevant to Ukrainian industry, like to any other industry, though seminar lectures are unable to address specific problems of every company. Still lecturers are open and eager to answer specific questions from the audience and try to involve people in discussing them. Seminars bring together specialists from different enterprises, who can establish personal contacts, discuss their problems, and share experience.

The evaluator would like to note the structure of the seminars. The first day of the seminar is devoted to lectures, which include general introduction to the seminar topic, several lectures on specific aspects of technology application, and the legal and regulatory aspects which gives attendees comprehensive information on the seminar subject. On the second day there is a visit to a Lviv enterprise to learn practical aspects of the issues followed by the general discussion on how theoretical knowledge learned in the seminar can be applied at the visited facility.

The seminar content was at a high professional level. Material presentations, though, would greatly benefit from better use of visual aids. This evaluator recommends using transparencies with basic ideas covered in presentations printed in big letters to make it easier for the audience to follow.

The training component of the program includes also teaching courses at I. Franko University and Lviv Polytechnical University. This evaluator attended the lecture from a pollution prevention course taught at Lviv Polytechnical University. The lecture was delivered at the Resource Center using its audio-visual equipment. The lecture was specifically about pollution prevention in the process of corrosion protection of materials in construction industry. The lecture was organized in an interactive format. A short movie showing the process was demonstrated to students. Then the lecturer, Petro Hrytsyshin, discussed with students how pollution prevention principles can be used in this process. Students were obviously interested in the subject and rather actively participated in the discussion. This course includes two parts: lectures on the theory of pollution prevention and practical sessions, which allow student to use their theoretical knowledge and get the feeling of applying pollution prevention principles to different technological processes.

The evaluator also discussed the possibilities of expanding the training program with ETTEC program managers and Dr. Markian Pavluykevich, Prorector of Lviv Polytechnical University. Besides regular student teaching, Lviv Polytechnical University also has the Institute of Qualification Enhancement, which provides professional education to industry specialists on a commercial basis. The Institute has more than 1000 students a year. There is a possibility to turn the seminars into a short intensive training course which could be incorporated into some Institute programs for technological engineers.

Recommendations:
ETTEC program should seek new possibilities to increase the audience of their seminars. Possible audiences could be representatives of local environmental and health authorities, students of business and economics, technological engineers either from industrial enterprises, or studying in the Institute of Qualification Enhancement of Polytechnical University, etc. Seminar presentations will benefit from better use of visual materials and wider use of audio-visual equipment of the Resource Center.

2. Products.
2.1. Short Course Manuals for ERI training program.

The training course taught to Ukrainian program participants at ERI at UCONN, in July 1995 was made up of four modules: Environmental Analysis, Pollution Control Technologies, Site Remediation Technologies, and Pollution Prevention. The course covered the current state-of-the-art technologies and lab procedures in the field of pollution control and treatment technologies. These technologies are used in all industrial countries, so they are appropriate for Ukraine as well. The content of the training course accurately met the needs of the participants who teach similar disciplines in universities in Lviv and can transfer the obtained knowledge to their students.This ensures that future specialists are educated not only in the current state of technology in Ukraine, but are also aware of the recent developments world-wide and will be ready to implement them in industry when economic conditions allow. Ukrainian participants felt that the course did not completely correspond to Ukrainian conditions because it did not include information on pollution control, treatment, and remediation in nuclear power industry, which is very important for Ukraine because of Chernobyl. Instead, the course covered hi-tech technologies. In the opinion of this evaluator it would be interesting and beneficial for participants if low-tech technologies were also covered in the course. At present a lot of R&D work is done in US and Canada on low-tech pollution treatment technologies, which combine the high efficiency of high-tech technologies and low costs. For example, technologies exist for removing heavy metals from industrial and mine discharge using live and dead biomass (peat, algae, yeast) and site remediation by growing different types of vegetation, among others. This evaluator gave a short report on these technologies at the Biotechnology seminar during a site visit.

The courses were comprehensive and covered all major aspects of the modules' subjects. Short course manuals prepared at ERI are generally made up of hard copies of transperancies used for lectures. Generally these are the outlines for the courses. Because these outlines are quite detailed they can be used as course-independent reference materials. All manuals provide a list of references which can be used as additional sources of information. The evaluator would like to mention the manuals; "Environmental Biotechnology" by Dr. Robert Fisher, "Site Remediation: Aeration Technologies" by Dr. George E. Hoag, and " Automatic Control Systems for Pollution Prevention" by Dr. Douglas J. Cooper, which also contain detailed information and can be used as text-books on these topics. Manuals can be effectively used by professionals in the field, e.g., they are presently used by professors from Lviv Polytechnical University to update their teaching materials. Unfortunately, because of their format most of the manuals cannot be used by students without additional instruction.

2.2. Summary of New Courses.

All currently taught new courses are offered at the Lviv Polytechnical University for students with an Environmental Technology concentration. The courses are on air emissions and waste water treatment and a course on pollution prevention. These courses were approved by the University Curriculum Committee for this concentration. These courses make up an important part of this concentration, which was not previously offered. Students are highly interested in the subjects covered by these courses which is reflected by high attendance and active class participation.

Proposal for a new course "Analytical Control of Industrial Waste and Their Treatment" was developed in the Chemistry Department of I. Franko State University. This course uses materials from the Environmental Analysis short course module of the ERI training program. Besides analytical techniques, this course discusses the issues of data collection and validation which previously were not covered in courses of analytical chemistry. These issues will be gaining more and more importance in Ukraine, because it will be necessary to ensure that obtained analytical data can be defended in court. This course still has to be approved by the Department Curriculum Committee.

2.3. Industry Seminar Materials.

The evaluator reviewed materials of five seminars already held in the Center. Seminar topics were: Pollution Prevention and Waste Minimization, Industrial Waste Water Treatment, Municipal Waste Water Treatment, Health and Safety Issues in Industry, and Environmental Biotechnology. Each seminar participant is provided with a complete set of seminar materials, and at least one copy is kept in the Center. Seminar materials contain full texts of delivered presentations. Besides technical issues, each seminar also covers the legal aspects of the covered topic and participants are provided with copies of appropriate Ukrainian laws and regulations, which makes them very useful for representatives of industry environmental control departments as a comprehensive reference source.

Information about the ETTEC program and Resource Center and about consulting and research capabilities are attached to every set of seminar materials. The evaluator also suggested preparing an information brief on the expertise of all program participants working in the universities and on lab analytical capabilities. The chemistry department of I. Franko State University has certified equipment for the analysis of heavy metals and organic compounds and can provide high quality consulting and analytical service in the field of analysis techniques and sample measurements. Information distributed to seminar participants is one way of marketing consulting and analytical services that ETTEC project participants can provide.

3. Resource Center.

At present the ETTEC Resource Center has a library of 107 titles, most of them in English. It has audio-visual and computer equipment. Computers have two databases: a database of library resources and a database of Lviv enterprises. Both databases are in Ukrainian and they have

convenient systems of information search. There is also an environmental program, "HyperVentilate", provided by ERI which allows the development and study of aeration site remediation systems. The program is very user-friendly and self-explanatory, so it can be used even for student work. The center's computers are connected to Internet.

Attendance of the Center is low, lower than was expected by the Ukrainian program managers. At present, the Center resources are used by teachers of Lviv universities and students doing research projects. So far people from industrial enterprises have not used the Center. This can be attributed to several reasons. The main one is that the very idea of a non-government resource center is very new in Ukraine. Traditionally, all technological information was distributed through industry regulatory structures. So it will take time for industry people to get used to the idea that the Center can serve as a source of valuable information for them. Other potential users are university teachers and students. Their attendance is inhibited by the remote location of the Center from both I. Franko and Lviv Polytechnical Universities. It will also take time for the students to really realize and appreciate the potential of the Center as a source of supplementary information for their study and research. This will gradually occur due to "word-of-mouth", that is information from friends and teachers who already used the Center. This process can be sped up by arranging tours of the Center for University students and including into University courses home assignments which would require use of the Center.

Another current obstacle for wide use of the Center is that most of the literature is in English. This problem is presently being solved as literature in Polish and Russian have been ordered. This evaluator suggested that student theses on environmental technology can be placed in the Center's library. These theses are usually of high quality and are written using recent information in the field. This will increase the quantity of literature sources. Using ETTEC logos on these theses will give them the status of publication, which has direct benefit to the students.

Recommendations:
One of the ways to increase attendance of the Center by University students is to arrange tours for them in collaboration with University faculty.
Student research works can be used as an additional source of literature for the Center.

D. What additional technical assistance the Ukrainian side could use to improve their work in general.

At present the most useful assistance for the Ukrainian side would be in providing more reference sources for the Center: literature, video materials, specialized computer programs. A good information source would be the journal "Pollution Prevention", published in the USA. This journal contains information on actual examples of successful applications of pollution prevention concepts in industry. UCONN would be able to assist the Center in subscribing to this journal.

E. New directions of the ETTEC project development.

The Ukrainian part of the ETTEC project is in the beginning stage. It is necessary to actively develop its educational possibilities. The course of seminars which were prepared this year can be turned into a course of intensive training to be integrated into the qualification enhancement programs for industrial engineers of Lviv Polytechnical State University. Another possibility is to obtain the status of a professional qualification enhancement program from the state regulatory board, similar to already existing ones.

The project promotes the idea of pollution prevention and waste minimization as a feasible and economic alternative to waste treatment and remediation. It is necessary to try to convey this idea to enterprise management and authorities. This can be done by arranging seminars on pollution prevention for senior management of industrial enterprises, which can be accomplished by securing the support of Lviv authorities. Courses or seminars on pollution prevention can be included in the curricula of economic and business administrations of Lviv institutions of higher learning. Pollution prevention should also be taught to all students within a technological concentration. The idea of pollution prevention is still very new in Ukraine and probably won't be that favorably accepted now because of the industrial crisis. Present students will get into decision making positions in about 8-10 years. So their education should try to foresee the technological requirements in 10 years. There is no doubt, and experience of all developed countries demonstrate this, that Ukrainian industry will also come to accept these ideas. Exposing students to these concepts now and giving them the understanding for applying pollution preventing concepts to different technological processes will be beneficial for industry in the long run.

F. Partnership sustainability plan.

Initially the idea was that after the project was over the Resource Center would support its activities through fees for seminar participation and a fee for using the Center. According to Volodymyr Tounytsky, all attempts to charge fees for seminar participation failed because Lviv enterprises suffer from crisis and a lack of cash and are not willing to pay anything for seminars. So in the next 2-3 years the principal source of financing will be grants from different international foundations and organizations. This is quite feasible for several reasons. First, activities of the Center fit not only in the environmental category, but also into the category of community service, which broadens the scope of grants the Center can apply for. Second, new international grant-giving organizations are starting operations in the NIS. For example, REC is planning to open centers in NIS, first of all in Russia, Ukraine and Georgia (personal communication with REC office in England). Also, the World Bank has began promoting ideas of eco-management in NIS countries. Recently the World Bank organized the seminar on this subject in Moscow. Pollution prevention is an important part of eco-management concepts, so the ETTEC partnership can contact the representative office of the World Bank to survey the possibilities of getting some financial support.

Recommendations:
Besides surveying possibilities for getting grants, the Center should try to investigate more possibilities for getting revenues from participation in commercial educational structures like qualification enhancement programs for specialists.

G. Other comments.
1. Analytical lab.

The analytical equipment which is used now at the Lviv Polytechnical and I. Franko Universities is outdated, though some are in quite good working condition. They reflect the level of equipment used in industrial and control labs in Ukraine. Modern equipment would increase the research capabilities of the University labs. The ability to work with modern equipment will enhance the quality of student training in general, though in their professional work they most likely will use much older equipment. At present, Ukrainian industry and regulatory bodies which are the principal potential consumers of analytical services, suffer from the lack of financing so they cannot use these services on a commercial basis. Universities, which are financed by the state, also have very small budgets, which usually cover only faculty salaries. Modern analytical equipment requires expenses for high maintenance, which the universities would not be able to bear, if this equipment is not used to its full capacity for commercial contracts. Under the present economic conditions in the Lviv region the modern analytical lab would not be able to operate full-time and be self-sustainable. The equipment which is used at present for educational purposes teaches students the main principles of analytical techniques. These basics would allow them in the future to quickly learn how to use more advanced equipment if they have to. So creating an advanced analytical lab in Lviv now is not sensible, because its costs would exceed its benefits.

2. Ability of University and World Lab staff to provide environmental consulting services.

University faculty and World Lab staff are fully capable of providing high quality environmental consulting services in the fields of analytical control and equipment and waste treatment technologies. World Lab, which is associated with a number of Lviv research institutions, can also provide R&D and consulting services on different technological issues, e.g. microplating, corrosion protection. But at present the market for these services in the Lviv region and in Ukraine in general is very small. Ukrainian enterprises and government institutions do not have money for these services. Foreign companies and institutions, which at present are the major consumers of environmental consulting services in NIS, do not have big investment projects in the area. Usually they prefer to work with western consulting companies. So in upcoming years getting consulting contracts will be a difficult task.